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Environmental Factors That Affect Kenneled Shelter Dogs in Connecticut

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Environmental Factors That Affect Kenneled Shelter Dogs in Connecticut

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CHAPTER 1

OVERVIEW OF HOW ENVIRONMENTAL FACTORS PLAY A ROLE IN GROWTH, PRODUCTION, AND WELFARE OF ANIMALS

INTRODUCTION

Assessing the welfare of domestic shelter dogs is inherently difficult. Researchers, (Puvadolpirod et al. 2000; Virden et al. 2009; Yuan et al. 2008) utilize cortisol measurements as a parameter to assess stress levels and to understand animal's behaviors. Unfortunately using this method alone can be ineffective. Cortisol levels can increase or decrease for many different reasons in animals (Coppola et al. 2006). Those levels can increase simply because you are taking blood or urine samples (Hiby et al. 2006) or because a visitor is approaching a dog's kennel. Many considerations have to be considered regarding the behavior of dogs found in animal shelter settings. The behavior of shelter dogs should be properly studied, including environmental parameters and how these affect their behavior. Studies of this matter are essential to understanding optimal conditions while housing dogs at re-homing shelters.

There are many environmental conditions which cause shelter dogs to be reactive, investigative, aggressive and/or fearful. There are also environmental factors which can enhance a dog's experience at a shelter. Management of environmental factors for dogs is pivotal for improving adaptability (Kogan et al. 2012) and welfare of the animals (Virden et al. 2009), particularly those in rehoming shelters. It has even been suggested that the welfare of sheltered dogs may be positively influenced by exposure to appropriate forms of olfactory stimulation such as lavender or chamomile (Graham et al. 2005). The environment can be defined as external

conditions which affect or have an impact on an animal's welfare, behavior, growth and/or development (Virden et al. 2009). Environmental factors can include nutrition, water and air quality, weather, climate, temperature, humidity, light, sound, scents, disease, overcrowding, and wastes.

There has been limited research on the effects of multiple environmental factors, such as acoustics, light, temperature, and humidity on kenneled shelter dog's health, welfare and behavior. However, there have been studies which evaluated some of these environmental factors with initial data collected. One of the most evaluated conditions for kenneled dogs is sound and acoustical levels. Sound is a source of major concern when studying kenneled shelter dogs. Most kennels have little to no acoustical baffling panels to absorb the excessive noise. Without baffling panels, the acoustics in kennels can reach well over 100dBA regularly. Scheifele et al.2012a, studied two kennels and reported equivalent sound level values ranging between 100 and 108 dBA sound pressure level for both kennels. At the end of 6 months, all 14 dogs that underwent hearing tests had a measured negative change in their ability to hear. Such levels could be considered dangerous for kenneled dogs, particularly given the demonstrated hearing loss for some of the dogs tested (Scheifele et al. 2012a).

While hearing loss is a major concern in kenneled shelter dogs, it is not the only environmental factor negatively impacting their behaviors and welfare. In many rehoming shelter dog facilities in Connecticut, dogs are kept in constant lighting due to the Occupational Safety Health Administration requirements of having emergency lights illuminated after the building is closed to the public. Unfortunately, housing dogs with constant light can also affect their behaviors and the natural circadian rhythm cycle. Since we could not locate scientific studies on the effects of light on kenneled dogs housed in shelters, we researched the effect of light on other

domestic animals. Animals housed with 24-hour lighting, even dimmed, could experience a disruption to their circadian rhythm cycle. Circadian rhythm is the natural pattern of physiological and behavioral processes that are timed to a near 24hour period (Blatchford et al. 2012). The natural circadian rhythm is affected by light and dark periods and is extremely important to the health and behavior of most domestic animals. These processes include sleep-wake cycles, body temperature, blood pressure, breeding cycles, and the release of hormones. Both body temperature and blood pressure are highly influenced by natural dark-light cycles but will persist under constant environmental conditions (Blatchford et al. 2012). In poultry studies, it was noted that birds raised under even constant dimmed light had larger, physically heavier eyes (Blatchford et al. 2012). The low intensity light periods did cause birds to continue to feed, so they had an increased weight gain when compared with birds that were exposed to natural dark and light periods. However, with constant low dim light there was also an increased lameness in birds and behavioral issues such as vent pecking (Olanrewaju et al. 2006). When light is maintained at a consistent level throughout the growth cycle of broiler chickens it correlates with slower development and physical growth abnormalities, thereby reducing efficiency (Olanrewaju et al. 2006).

Not only does light affect the overall behavioral response of animals, but it also affects hormone production. Melatonin is a powerful hormone which helps animals sleep, strengthens the immune system and combats inflammation (Olanrewaju et al. 2006). Melatonin levels can be absent or very low during constant light periods. Additional hormones affected are thyroid hormones such as triiodothyronine(T3) and thyroxin(T4), which ultimately affect growth, development and reproduction (Olanrewaju et al. 2006). These hormones can serve as both a growth promoter and growth inhibitor under certain lighting conditions. It is possible that under

certain lighting conditions thyroid hormones may be stimulated to encourage greater growth periods (Olanrewaju et al. 2006). Understanding how constant lighting has affected other species is important to know because it could explain how constant lighting may affect the behavior, health and welfare of domestic shelter dogs. The importance of controlling lighting settings ensures that dogs housed in kennels within shelters are being exposed to the most optimal conditions while impacting behavioral management in a positive way.

Another area of concern for kenneled shelter dogs is being exposed to excessive hot or cold temperatures and humidity. Excessive temperatures and fluctuations are known to cause stress in domestic animals as well as humans. Temperature and humidity can vary so drastically from shelter to shelter due to many facilities being built with having their kennels open to the outdoor elements. In the summer months', dogs overheating is a real concern because of high temperature and humidity levels. Heat stress may occur due to being confined to an overheated area for a period of time (Lewis et al. 1976). Many elements can be involved in stressing an animal to a point where heat stress occurs. However, for kenneled shelter dogs, high ambient heat, elevated humidity levels, constant pacing, barking and other stimuli can cause dogs to overheat in a relatively short period of time.

Heat stress, much like circadian rhythm, is known to cause physiological changes in all species of animals. Studies conducted with dairy cattle noted that milk yield significantly declined when temperature levels were high (Cook et al. 2007). The level of cortisol in the blood increased significantly in cows exposed to high temperature, indicating the occurrence of heat stress. Heat stress during rapid growth has also been associated with undesirable meat characteristics in both turkeys and broiler chickens (Sandercock et al. 2001, Imik et al. 2012 and Marin et al. 2002). Heat stress also reduces the expression of estrous behavior and embryonic

development in Holstein cows (Ingraham et al. 1976). Understanding the full scope of the effects of heat stress is further complicated because it has both an immediate and delayed impact on the reproductive system in beef cattle (Wolfenson et al. 1995). Management of environmental factors are critical to understanding the effects of excessive temperature fluctuations on dog's welfare and behavior as well as their potential adoptability.

LITERATURE REVIEW

Environmental Factors - Sound

Life expectancy of a dog taken to a shelter will be affected by the environmental factors found at the kennel. Environmental factors have been known to either hinder or compliment growth and production in domestic livestock animals (Virden et al. 2009 & Yuan et al. 2008). Environmental factors, including the building design of kennels, have been shown to either positively or negatively affect dogs housed in them due to increased decibel levels directly associated with the type of construction (Key, 2008).

Not much research has been conducted in the area of the effects of environmental factors on kenneled shelter dogs with the exception of acoustical levels. Many researchers have focused on the harmful effects that elevated sound pressure levels have caused on dog's hearing ability in sheltering environments (Scheifele et al. 2012a, Coppola et al. 2006, &Sales et al. 1997). However, one study conducted in a humane society shelter reported that elevated noise levels can result in immunosuppression, insulin resistance, cardiovascular diseases, catabolism and intestinal problems (Coppola et al. 2006). This facility was constructed in 1999 with concrete blocks and metal roofing without acoustical paneling. Over an 84-hour period, including two weekdays and two weekends, peak sound levels regularly exceeded the capabilities of the dosimeter which maxed out at 118.9dBA's. (Coppola et al. 2006). This sound level could

potentially damage canines hearing permanently, which could eventually lead to behavioral problems. The behavioral issues commonly recognized in shelter dogs such as loud incessant barking causes them to be deemed unadoptable and therefore ultimately euthanized. Research has shown that a shelter dogs behavior determines whether or not the animal will be regarded as desirable by potential adopters (Wells & Hepper, 1999).

Focusing on acoustical levels, allows for noise abatement systems to be analyzed. Acoustical panels are one area of abatement that can be addressed. Another area that can be focused on is the overall design of kennels. Dog's sensitivity to sound is twice the ability of humans, distinguishing sounds ranging in the rate of 40Hz and up to 50kHz, which is well beyond the 20kHz upper frequency point of human audible range (Sales et al. 1997, Scheifele et al. 2006, 2012a, 2012b). Noise abatement strategies should be a standard part of kennel design and operation when such kennels are intended for rescue housing of dogs. Noise exposure also affects the employees that are caring for these animals as well as the public viewing the dogs in the kennel. Scheifele et al. (2012a) noted that results of their noise assessments indicated levels that are damaging to the human auditory system. Constant stimuli from visitors and employees walking through kennel areas, as well as the dogs themselves, have the ability to keep noise levels consistently over 100dBA's for eight or more hours during a normal business day.

The sound levels noted up to this point are well known to cause adverse effects in many species (Sales et al. 1997). Even if dogs did not find elevated sound levels to be a detriment, any physiological damage reduces the dog's wellbeing and in scientific analyses may be considered an uncontrolled variable (Sales et al. 1997). Other studies have shown that specific auditory noises such as classical music within kennels may have a positive effect on kenneled shelter dog's behaviors. Kogan et al. (2012) conducted a study at an animal shelter in Colorado with

the capacity of 160 dogs. Their conclusion was that kenneled shelter dogs can be negatively or positively impacted by the types of music being played in the kennel area.

Kujawa and Liberman (2009), noted that being consistently exposed to powerful, loud sound can cause temporary or permanent hearing loss. Their research consisted of male mice at 16 weeks of age being exposed to 100 dBA's for 2 hours. Outcomes suggested that noise-induced damage to the ear has progressive significances that are noticeably more abundant than are realized by typical threshold testing. Primary neurodegeneration can add to difficulties hearing in noisy environments. This degeneration could contribute to tinnitus and other perceptual irregularities commonly related with inner ear damage. The quantitative examination of hair cell synapses, cochlear nerve terminals and SGCs proposes a different outcome which is that the acute noise-induced damage to cochlear nerve terminals is irreversible (Kujawa and Liberman 2009). The primary neural degeneration defined within this context likely occurs in noise-exposed human ears as well. Studies have shown that severe noise-induced enlargement of cochlear-nerve terminals has been detected in many mammals that were studied. Some of these mammals include cats (Liberman, 1982), guinea pigs (Robertson 1983; Pujol et al. 1993) and mice (Wang et al. 2002). It is disconcerting to deliberate that normal threshold sensitivity can cause dramatic neural degeneration in noise-exposed ears. Federal exposure guidelines provided by organizations like OSHA aim to protect against permanent threshold damage, a method that assumes that reversible threshold shifts are related with benign levels of exposure (Kujawa and Liberman 2009; OSHA.gov, 2017). Kujawa and Liberman (2009) contradict the fundamental assumptions by showing that reversibility of noise-induced threshold shifts is only covering progressive underlying neuropathology that likely has profound longstanding negative costs on auditory processing ability. The strong suggestion is that noise exposure is much more dangerous

than has been previously assumed (Kujawa and Liberman, 2009). Dogs with long-term exposure to excessive noise will also likely cause irreversible damage, which in turn could cause behavioral issues both in and out of kennel shelter settings.

An abatement and/or modification system could potentially impact these dogs in a multitude of ways (Coppola et al. 2006; Key, D., 2008). By modifying certain environmental factors within kennels to allow dogs to be more comfortable and less stressed can ultimately cause them to be considered adoptable (Bergamasco et al. 2010). Potential adopters may be exposed to better behaved dogs within their kennels. This could in turn encourage both shelter staff and potential adopters to spend more time with dogs. This may ultimately affect dogs by exhibiting more socially acceptable skills and therefore becoming more adoptable.

Environmental Factors - Light

In addition to acoustical levels in shelter environments, there is a great concern about how lighting factors affect kenneled shelter dog's behaviors. Many shelters house dogs in full light 24 hours a day. This is due in part because emergency lighting is required to stay on in many facilities, in case of emergencies at night (OSHA, 2017). Limited research on how domestic dogs in kennels react or behave to lighting conditions have been conducted in this area.

Research on how other domestic animals behave under different lighting conditions, such as domestic livestock, have shown to have adverse reactions to constant or dimmed lighting conditions. Lighting factors evaluated according to duration, intensity, and wavelength, indicated that this may be the most prevalent of all the environmental influences affecting birds (Olanrewaju et al. 2006). This is partially due to the fact that chickens are extremely sensitive to

changes in light, color, intensity and duration (Rogers et al. 2015 & Cao et al. 2012). Animals exposed to constant lighting may become distressed which can change physiological functions. Stressful conditions caused by lighting conditions can result in a redistribution of body resources, including energy and protein, at the expense of decreased growth, reproduction and health (Virden et al. 2009). Chronic stress can result in birds becoming fatigued and weak, which can lead to a weakened immune system and increased susceptibility to infectious diseases. Chickens under constant stress can become distressed (Virden et al. 2009). However, birds given outdoor access had greater bone strength and were considered healthier and less distressed than birds not given outdoor access (Fanatico et al. 2005) Studies involving canines exposed to constant lighting would need to be completed to determine if they would have similar physiological reactions or maladaptive behaviors.

Kendall et al. (2007) documented that light cycles affected the milking frequency and had an effect on the circadian body temperature rhythm in Holstein dairy cattle, and that with constant light periods, there was a decline in body temperature which caused milking frequency to be reduced. The alterations in the circadian body temperature rhythm with milking frequency were likely due to differences in metabolic activity and internal heat production. The practice of exposing dairy cattle to constant light to help increase milk production, may actually show a decrease in milk production due to stress on the animals for not receiving the natural dark periods for rest and rejuvenation (Kendall et al. 2007). Photoperiodism provides the necessary changes in light intensity and darkness to allow for rest, repair, growth, and energy restoration (Kendall et al. 2007). Olanrewaju et al. (2006), showed that chickens exposed to high intensity, continuous lighting developed eye and leg problems and had higher mortality rates. Once again, while these studies are not directly correlated with canines, they do provide us with some vital

information on how light affects animals under different conditions.

Another study conducted by Rogers et al. (2015) used different types of light to investigate weight gain in birds. The technology options included light emitting diode (LED), incandescent lamps and cold cathode fluorescent lamps. These lighting options offer different colors (wavelengths) and intensities. Chickens exposed to higher stress levels spent less time eating (Rogers et al. 2015). Stress levels were determined by measuring the blood levels via cardiac puncture to determine heterophil to lymphocyte ratios (Rogers et al. 2015). Their results indicated a general trend in greater body weights and lower stress levels with the use of incandescent lamps. Birds raised under these conditions may grow and develop more efficiently while also costing less money. This study highlighted the importance of bulb types used when correlating stress levels and weight gain in poultry.

In addition to bulb type affecting birds body weights and stress levels, the color of lights can affect them as well. Cao et al. (2012) suggested that chickens are sensitive to changes in the wavelength of light, when they observed that birds raised under a combination of different monochromatic lights dependent on their ages, had heavier body weights. Chicken's visual perception of wavelength of light is broader than that of mammals, so there is negative response in their overall growth and development of these birds when housed in lighting conditions that are not compatible (Cao et al. 2012). Although chickens may receive light differently than mammals, the relationship of being affected by the natural dark and light periods would most likely not differ (Olanrewaju et al. 2006). More research is needed in this area to determine if using monochromatic lights at night, would enhance dog's behaviors in a positive manner at shelters.

Environmental Factors – Temperature and Humidity

An important concern is that many dogs housed in kennels are exposed to different temperatures and humidity throughout the seasons. Heat and cold stress are serious concerns for shelter dogs that are openly exposed to the constantly changing elements. Heat stress can be defined as a negative balance between the amount of energy going from the animal's body to its immediate environment and the extent of energy produced by the animal (Lara et al. 2013). This imbalance may be caused by a multitude of environmental factors, which include sunlight, air temperature, humidity, overcrowding, pacing, and barking, outside or inside stimuli among others.

To fully understand how variations in temperature and humidity may affect the health and welfare of domestic canines housed in kennels, we must first investigate the physiological responses of dogs to environmental stressors. An undesirable aspect of allowing kenneled shelter dogs outdoor access is that they are exposed to several environmental factors that can cause negative effects on their health and welfare. Examples of these negative environmental factors include fluctuations in temperature, such as extreme cold and hot weather conditions, and excessive or constant stimuli during both the day and night. Heat stress can be a real concern to dogs with outdoor access kennels. These dogs are confined to small cages with limited ventilation and many times are continuously pacing and barking. Three quarters of heat loss in dogs is done so by radiation and convection (Bruchim et al. 2006). As temperature increases and the body temperature tries to maintain an equilibrium, dogs tend to begin panting and sweating through their paw pads, to help maintain normothermia (Bruchim et al. 2006). The nasal cavities provide a big surface area for water loss from the mucous membranes. They also play a vital role in the evaporative cooling mechanism (Bruchim et al. 2006). Limited research has been

conducted in the areas of canines and heat stress, other studies on animal species reveal valuable information.

Heat stress can be either acute or chronic. Acute heat stress occurs when temperatures increase significantly for a short duration. Chickens can become acclimated to some repeated short exposures to acute heat stress (Altan et al. 2000). However, chronic heat stress, which occurs over long periods of time, can depress broiler growth (Al-Fataftah et al. 2007). Under chronic heat stress poultry are exposed to high temperatures and humidity conditions constantly. Poultry then alter their behavior and physiological responses seeking their natural homeostasis which causes them to spend less time feeding and more time panting and drinking water (Al-Fataftah et al. 2007). They also tend to sit with their wings expressed to help relieve heat. Most animals have unique ways to thermoregulate when subjected to increased environmental temperatures. Birds utilize air sacs to help panting be more productive by releasing heat into the environment and to help thermoregulation (Lara et al. 2013). Unfortunately, with the increased use of panting and reliance on their air sacs also comes an increase in carbon dioxide levels and higher blood pH (Lara et al. 2013). This can cause a negative energy balance and a decrease in calcium uptake which could lead to broken bones or lameness (Lara et al. 2013). Calcium is an important factor in poultry health due to its role in ensuring bone strength, muscle growth and contraction and skeletal function (Weglarz et al. 2013). In addition, Warriss et al. 2015, conducted a study in which they found that the highest mortality rates of broiler birds happened in the summer months due to a combination of increased temperatures, transportation of birds and heat stress.

No publications could be located on the effects of cold stress on dogs in kennels housed in shelters. The only information found relating to dogs in kennels regarding cold stress was

from the United States Department of Agriculture which touches on cold stress causing muscle weakness, lowered rectal temperature, and shivering. However, after evaluating dogs in these conditions and speaking with both Veterinarians and Dog Trainers, many shiver in order to maintain their core body temperature. Many of the dogs will also curl up into tight balls to maintain body heat as well. Dogs that are housed outside of Connecticut shelters can have multiple dogs per kennel. This will allow them to sleep on top of each other or very close to each other to help maintain their body temperature as well. In addition, it was noted that many dogs housed with outdoor access kennels constantly had wet feet and legs from being exposed to the outside elements. They also possessed sores on their legs and feet from constant wetness. More research into this area needs to be conducted to understand the physiological and psychological effects of shelter dogs housed in these conditions.

Dog variables that were evaluated throughout this study were sex, altered versus unaltered and dogs labeled as pit bull type breeds versus other breeds. These factors were then analyzed utilizing temperature, humidity, sound and light. Excessive hot and cold temperatures were noted especially in combination with maladaptive behaviors. Elevated sound and light levels were also observed in combination with maladaptive behaviors of dogs. These environmental factors were analyzed to further understand how they contribute to maladaptive behaviors in kenneled shelters dog thereby contributing to those dogs being deemed unadoptable and ultimately euthanized.

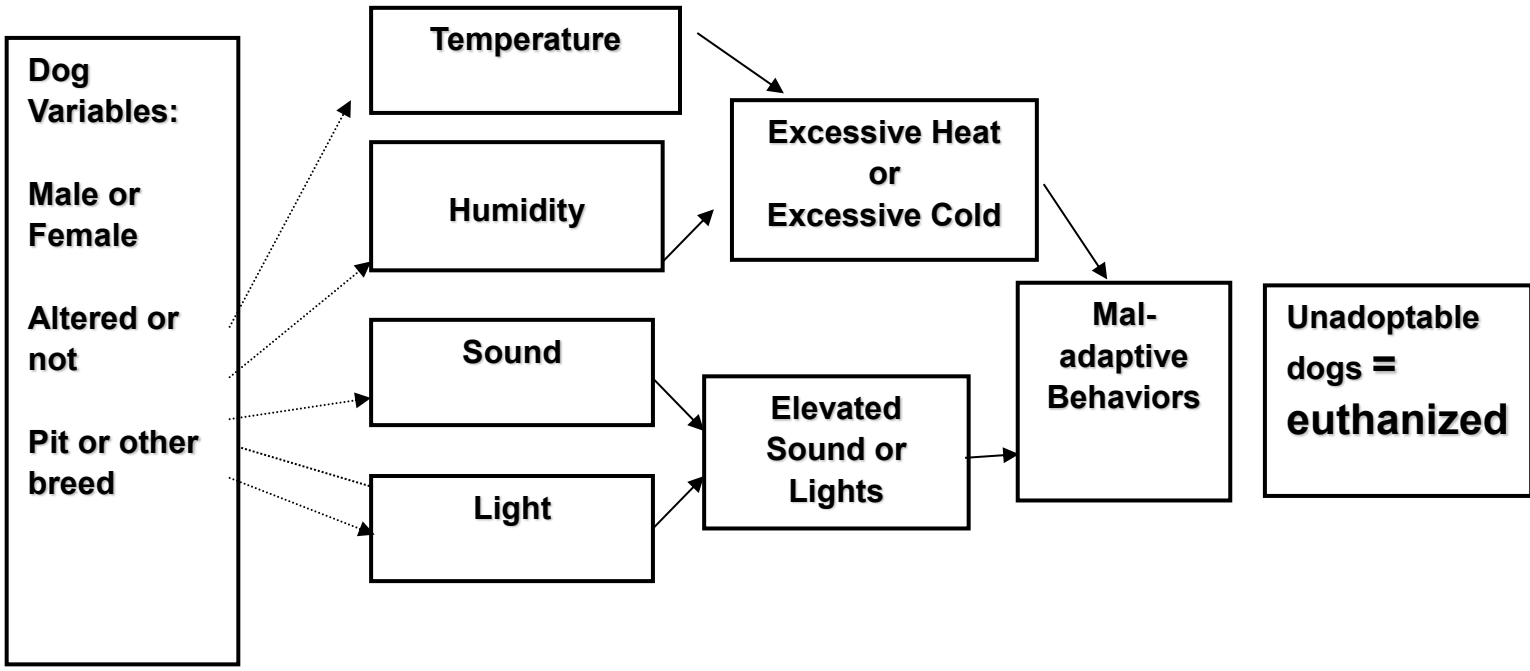

Figure 1.

Dog variables and environmental factors that could contribute to maladaptive behaviors in kenneled shelter dogs in Connecticut.

GOALS AND OBJECTIVES

The goal of this master's thesis is solving a problem relevant to canines housed in sheltering facilities throughout the state of Connecticut. This study has been based on existing scientific knowledge (shown through the Literature Review) and has been conducted with the principles of responsible research. The ultimate goal is to determine how environmental factors within the kennel affect kenneled shelter dogs. The hypothesis is that kenneled shelter dog's behaviors deteriorate when exposed to elevated acoustical levels, fluctuating temperature and humidity levels, and excessively bright, dim, or inadequate light levels and length of photoperiod. Kennels were built as warehouse type facilities without any consideration for fluctuations in environmental factors and how that may stress dogs.

Specific Objectives

1. To measure these specific environmental factors that contribute to dog's stress levels, as indicated by maladaptive behaviors, such as excessive barking, restlessness, growling, jumping, circling or climbing, longer than normal periods of inactivity, and extreme submissive or aggressive behaviors.
2. To evaluate shaking, shivering, whining behaviors as well as how the dog is positioned in the kennel.
3. To develop standards and put in place controls and monitoring systems to adjust these factors to ultimately make dogs more adoptable while being housed in sheltering facilities.

METHODS

Subjects and Housing

Researching light and acoustical levels, temperature and humidity as the main focus of environmental factors for kenneled shelter dogs in Connecticut has given us initial data to better understand optimal housing conditions. Ninety-seven dogs (52 males [35 neutered], 45 females [30 spayed]) of mixed breeds were housed in kennels at seven different animal adoption shelter locations in Connecticut. The research took place between September 2013 through June 2015. Dogs were approximately between 12 weeks old to 10 years old (exact ages were difficult to determine due to many dogs being strays or their owners not providing documentation). All of the sheltering facilities were of concrete block construction with epoxy floors except for two locations which consisted of stainless steel frame material and epoxy floors. Given the first objective, focus was placed in collecting measurements of acoustical levels, light levels and duration, and temperature and humidity levels. This was also done in conjunction with recording shelter kenneled dog's behaviors. Behaviors were then evaluated behaviors during these time frames to see if dogs housed in kennels within shelters were negatively or positively impacted by these environmental factors.

The equipment used to evaluate environmental factors were, for sound: two Extech Digital Sound level meters, (Models 407730, 407732); for light: an Amprobe Light meters (Model LM-100); for temperature and humidity: a LA Crosse technology temperature humidity meter (Model 9029), an Extech Digital Hygrometer (Model 445582); for audio and video: a Dell

Inspirion Laptop Computer– for digital video and audio recordings and one Logitech portable Webcam (Model GG-01). Other data was recorded in field journals. These data were collected simultaneously with the dogs behaviors while in the kennels.

Acoustical (noise/sound) levels were determined using two sound level meters. Both meters were read at 18 inches above floor level placed onto plastic folding tables, which is relative to the average dog's height when standing. One meter was placed to the left side of the kennel (if allowable) and one meter placed to the right side of the kennel (if allowable). Each meter's placement was consistent with regard to distance away from the nearest kennel. All equipment, including myself, were in place at least one hour prior to start of recording so the dogs could acclimatize to their presence. The sound level meters were set to read in units of dBA on slow and measurements were taken at randomized times for randomized minutes. Acoustical levels were analyzed by evaluating intensity levels that the American Academy for Audiology and Occupational Safety and Health Administration considered soft, loud, very loud and dangerous ranges (AAA, 2017 and OSHA, 2017). These levels, while utilized for humans, provide us with a base level to be considered. FETCHLAB USA has also set Permissible Exposure Levels(PEL) for military canines and Hollywood movie canines at 80dBA(Scheifele,2016).

Other considerations were noted while collecting data within these seven shelter facilities. Outside weather was notated as a point of reference for inside readings. Humidity and fluctuating outside temperatures affected the shelters that had inside and outside access kennels. This caused a fluctuation of both temperature and humidity as well as lighting levels. Types and quantity of food being fed to dogs was also be recorded. Enrichment and exercise programs

being offered to dogs was notated in the data collected as well.

Poor kennel construction and poor management of environmental factors may negatively impact millions of dogs each year (Coppola et al. 2006; Kiddie and Collins, 2015; Bergamasco et al. 2010; Key, D., 2008). Because of the potentially failing environmental adaptations millions of dogs are euthanized every year. A combination of constantly fluctuating temperatures and humidity, extremes in light levels and duration, along with elevated acoustical levels, has the potential to cause such mal adaptive behaviors in a majority of kenneled shelter dogs, that they are deemed unadoptable.

Each kennel set up is unique to that particular building, so access was allowed either during certain time frames, certain dates or during a specific period. The design used was a completely randomized design utilizing as many dogs as are available at the time of data collection. Each facility's kennel was monitored for a minimum 4-hour time period and a maximum of 24 hours. Hourly readings were taken at randomly selected time periods. The treatments being monitored were evaluated by passively observing and journaling as well as videoing behavioral responses while collecting environmental factors such as sound, light, temperature, and humidity which are all naturally occurring states that are being analyzed to determine the behavioral effects on the kenneled shelter dog's states.

All subjects analyzed were domestic canines housed in kennel shelter environments for adoption. These dogs were subjected to all the elements being studied on a daily basis just by natural occurrence of living in the kennels. Each facility varied in how often the dogs are fed, types of food, cleaning products, noise abatements systems, kennel design, temperature and humidity levels and odors that the dogs are exposed to. All data collection was passive in nature

and did not require interaction or handling of any dogs.

Data Analyses

In the analyses, variables corresponding to sound, temperature and humidity were recategorized into two or three levels, and variables on breed and stress were transferred to binary variables (0 for non-pitbull and non-stress, 1 for pitbull and stress). In this way, all the variables were categorical. Frequency tables were used to summarize the observations or dogs with respect to the variables, while a generalized linear mixed effects model with logit link was used to compare the stress status in different situations within dogs. Additionally, figures of frequencies and of "proportion of stress" were given in the analyses.

All statistical analyses were performed in R 3.5.0. And R packages "readxl", "ggplot2", "Rmisc" , "lme4" and "lmerTest" were applied to analyze the data. A p-value less than 0.05 was deemed to be statistically significant. Thus, breed, Neuter/Spayed, sound and temperature had a significant influence on dogs' stress status in the framework of generalized linear mixed effects model.

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Dog Behavior Evaluation

Dog's behaviors were evaluated by categorizing them into three categories. They were considered resting, alert or stress. Levels of behaviors for dogs in kennels in Connecticut we listed as follows: Rest was defined as dogs in kennels laying down, sleeping, or sitting down without any vocalizations. Alert was defined as pacing, barking, whining, shaking, jumping, lay and whine, sit and whine, walk and whine, stand and whine, sit and bark, stand and bark, walk

and bark or jump and bark. Stress was defined as lay, shake and whine, sit, shake and whine, circling, lunging, scratch and whine in anybody position, stand, shake and whine, circle and bark, lung and bark, stand and bite at fencing, lung, bark and jump, circle, lung, and bark, bark, jump, and circle, bark, jump, circle, and lung and any combination of these with growling or groaning included. These categorizations were based upon my own experience as the Director of an animal shelter and animal control department and having more than 20,000 hours of observing and working with canines. Veterinarians Dr. Scott Gavaletz and Dr. John Beres were both consulted in this process.Dr. John Beres owns East Shore Veterinary Hospital and boarding facility in Branford as well as East Shore's Animal Wellness Center in Madison, Connecticut. Dr. Beres has been a Veterinarian since 2004. Dr. Scott Gavaletz owns Branford Veterinary Hospital in Branford, Connecticut. Dr. Gavaletz has been a Veterinarian since 2002. Certified Dog Trainer, Stephanie Williams, was also consulted with regarding these levels. Ms. Williams owns the business K9 Pros and has worked with hundreds of dogs at the Dan Cosgrove Animal Shelter in Branford and other shelters for 7 years. They assisted in developing the categories and defining the levels.

CHAPTER 2

EFFECT OF ENVIRONMENTAL STRESSORS

Behaviors of Dogs Exposed to Environmental Stressors

Some environmental stressors in dog kennel settings could include temperature, humidity, light, sound, odors, guests visiting the shelter, staff cleaning the dog kennels, the addition of new dogs amongst many other stressors. Scientists, Jean Kiddie and Lisa Collins,

analyzed a previously developed quality of life assessment tool to determine the quality of life for dogs being housed in adoptable shelters (Kiddie and Collins, 2008). The (QoL) Quality of Life assessment tool utilized by Kiddie and Collins was updated to include new evaluation tools in the rehoming centers including environmental and management factors that were recorded by center managers. Center managers were asked to fill out a questionnaire related to the sound levels in the kennels, the kennel design, what the dogs were fed and how much as well as any enrichment provided which included human interactions. This study found that there were considerable variances with the 13 rehoming centers that were evaluated. The amount of human interaction, quantity and types of food fed, training, noise levels and bedding were all factors that varied greatly from center to center. This study did find that there was no statistical difference in the sound levels amongst the 13 rehoming centers. However, it was noted that higher quality of life scores for dogs in rehoming centers were noted in quieter environments. Hennessey et al. (2002) researched dogs in a rehoming center and human interaction along with a higher quality dog food diet and found that this combination may positively affect the behavior of shelter dogs. Since every shelter is managed differently, these differences are typically caused by differences in management techniques and that there is a lack of universal policy and procedures for animal rehoming centers. Berns et al. (2015) also found that positive human interaction with dogs created a less stressful environment for dogs (therefore potentially increasing higher quality of life) and increased the likelihood that dogs would react positively to other visiting humans. This may mean that both visitors and staff may spend more time in the quieter rehoming centers so those dogs may be adopted more readily therefore less are being euthanized.

Deborah Wells (2003), stated that rescue shelters are extremely noisy environments and that by adding any additional agitation or stress may cause more behavioral problems. It has

previously been stated that dogs that exhibit more maladaptive behaviors are not adopted and are euthanized in higher rates. Wells also noted that dogs need a complex and stimulating inanimate environment to ensure adequate psychological well-being in kenneled shelter dogs (Wells, 2004).

Coppola et al. (2006), Hewison et al. (2014) and Scheifele et al. (2012) also found that dogs exposed to continuous high noise levels could have catastrophic effects on their health and well-being. Dogs that are exposed to constant high noise levels have been shown to develop mal-adaptive behaviors over time (Coppola et al. 2006). Dogs that are housed in adoption kennel facilities are often exposed to noise levels which regularly exceeded 118.9dBA (Coppola et al. 2006). Permissible noise levels in decibels for human at 155dBA is 15-minutes without being provided with hearing protection equipment (OSHA.gov). Yet dogs are consistently kept in noisy environments without any protection and assumedly have hearing damage that is being caused by their environment. Working dogs such as military dogs that are required to ride in helicopters are exposed to decibel levels as high as 122dBA without being provided any hearing protection equipment. While the military human counterparts are required to wear them for protection so that they do not have damage caused by the constant exposure (Scheifele et al. 2012).

A study that eliminated visitors from having access to dog kennels evaluated how the noise levels varied once visitors were allowed back in. This study found that visitors may cause dogs to arouse in a negative fashion (Hewison et al. 2014). When these scientists restricted visitor access they found a reduction in noise levels. They also found that the dogs were more sedentary (Hewison et al. 2014). While this study found that noise levels were reduced, they also noted that cortisol levels did not change during this study (Hewison et al. 2014). This study suggests that while dogs may continue to be stressed even with decreased noise production, the

potential downside to limiting access to visitors is that adoptable dogs will not be seen; therefore, could impact their chances of being adopted.

Behavioral testing is an important tool in evaluating dogs in adoption centers, dogs purchased for specific jobs such as police dogs and dogs used for breeding purposes (McGarrity et al. 2002). Barnard et al. 2012, Dowling-Guyer et al. 2010 and Mirko et al. 2013, found that temperament testing dogs for behavioral issues was important in the adoption process. Walker et al. 2016, indicated that shelter dogs endured longer than average panting times, lifting of their paws, excessive drinking of water, tail wagging, barking, and whining when compared to pet dogs. They also noted the constant arousal in shelter dogs may indicate increased maladaptive behaviors when compared to pet dogs living in home environments. Jagoe 1994, for example, found that dogs that are housed in caged environments such as kennels and are adopted from animal shelters show a higher likelihood of social fear as opposed to dogs who are acquired from other places. Jagoe also concluded that dogs rescued from animal shelters may be more fearful of unknown humans when compared to dogs living in home environments. Hubrecht et al. 1992 noted that dogs that were housed singularly in kennels behaved in a more depressed manner than dogs that were housed with another dog companion in a kennel shelter. Research conducted by Wells and Hepper, 2000, Part et al. 2014 and Protopopova et al. 2016 also furthered the understanding that canines housed in kennels at rescue shelters are more likely to develop behavioral problems while at the shelters due to social isolation, excessive noise levels and fear from the unfamiliar surroundings.

Stephen & Ledger (2005) found that dogs entering rehoming centers are exposed to potentially stressful experiences that they were never exposed to in a home setting. Some of

these experiences could include unfamiliar, sights, sounds, smells, people and other dogs (Stephen & Ledger, 2005). One area that has not been studied at any length is temperature and humidity and how that affects kenneled shelter dogs. A dog's normal body temperature range is typically between 101-102° F. Dogs regulate their body temperature by panting, which causes an evaporatory reaction. According to the United States Department of Agriculture it can take anywhere between 7-60 days to acclimatize to the temperatures in a kennel setting. There are many factors that can affect this from their coat length, their breed, the size of the dog and whether or not the dog had been previously living in the same temperature environment already. When dogs cannot acclimatize to the kennel due to increased hot temperatures dogs may exhibit signs of excessive panting and salivation, restlessness, anxiety and weakness (USDA, 2017). If dogs body temperature reaches 104.0 °F it could cause heatstroke and ultimately death. On the other hand, dogs which are not acclimated and are exposed to extreme cold temperatures in kennel settings are at risk for hypothermia (USDA,2017). Risk factors for dogs living in kennels include shelter or kennel environments less than 45 degrees Fahrenheit, dogs that have become wet, small breeds of dogs, dogs that have injuries or health issues, elderly dogs and many others (USDA,2017). Signs of hypothermia could include mental lethargy, weakness, shivering, labored breathing, low blood pressure amongst many other signs (USDA,2017). All of these factors that dogs are exposed to could decrease their ability to be adopted since potential adopters do not want to adopt a potentially sick or unhealthy-looking animal. Scientific studies of kenneled shelter dogs that are exposed to extreme temperatures should continue to be evaluated to better determine their welfare standards and effects on adoptability.

Light levels, once again, have not been evaluated in kenneled shelter dog settings. However there have been other animals evaluated with different light levels. Studies evaluating

broilers have shown the growth and productivity of these birds when exposed to different lighting technologies (Cao et al. 2012). The color of light was especially important to the increased body weight production of broilers (Cao et al. 2012). In addition to the color of light, the duration of light has also been known to either increase or decrease both welfare and productivity in poultry. In a study conducted by Lien et al. (2009), the scientists evaluated the influence of long durations of bright light and increasing dim photoperiods and how that affected broilers. They found that allowing broilers to have 18 hours of light with 6 hours of dark caused them to be numerically heavier than broilers exposed to constant brightness (Lien et al. 2009). This study may suggest that poultry have a better quality of life when given hours of darkness in addition to hours of brightness. Dogs that are exposed to constant lighting (even if dimmed) may also be at risk for decreased welfare which could cause them to be considered unadoptable as well.

Environmental factors could be a major component on whether dogs in shelters are adopted or euthanized. These components need to continue to be researched and evaluated to understand the full scope of their effects on both the dogs housed in the shelters as well as how they affect the visitors visiting. On average most people do not want to be exposed to excessively loud environments for extended periods of time nor do they want to be exposed to excessive hot or cold environments for extended periods of time. All of these environmental factors mentioned need serious consideration in order prevent dogs being euthanized and better welfare being offered for dogs being housed in shelter facilities.

CHAPTER 3

RESULTS

Data Evaluation

There was a total of 768 observations and 97 dogs evaluated at 7 shelters in Connecticut. Out of those 768 observations, there were 19 observations within what we consider ideal conditions. The ideal conditions would consist of the Canine Comfort Index recommendations levels. There were 217 sound observations below 80 dBA and 551 observations above 80 dBA. There were 237 observations below 65° F, 508 observations between 65-75° F and 23 observations above 75° F. There were also 161 observations below 45 % humidity, 28 observations between 45-55 % humidity and 579 observations above 55 % humidity. When temperature is combined with humidity it can affect how hot or cold it feels as well as the wetness on the floors of the kennels. In cold weather below 50° F with a high humidity, it can be extremely wet in the kennels while also feeling very cold and clammy. In the same vein if it is extremely hot with temperatures above 80 ° F, combined with a high humidity, it can be extremely intolerable in the kennels.

The combination of these above environmental factors coupled with dogs' sex, altered versus unaltered, pit bull breeds versus other breeds are all used to evaluate dogs' behaviors in kenneled shelter settings within Connecticut. These Figures below show the amount of observations as well as the percentage of stress observed.as indicated by their maladaptive behaviors.

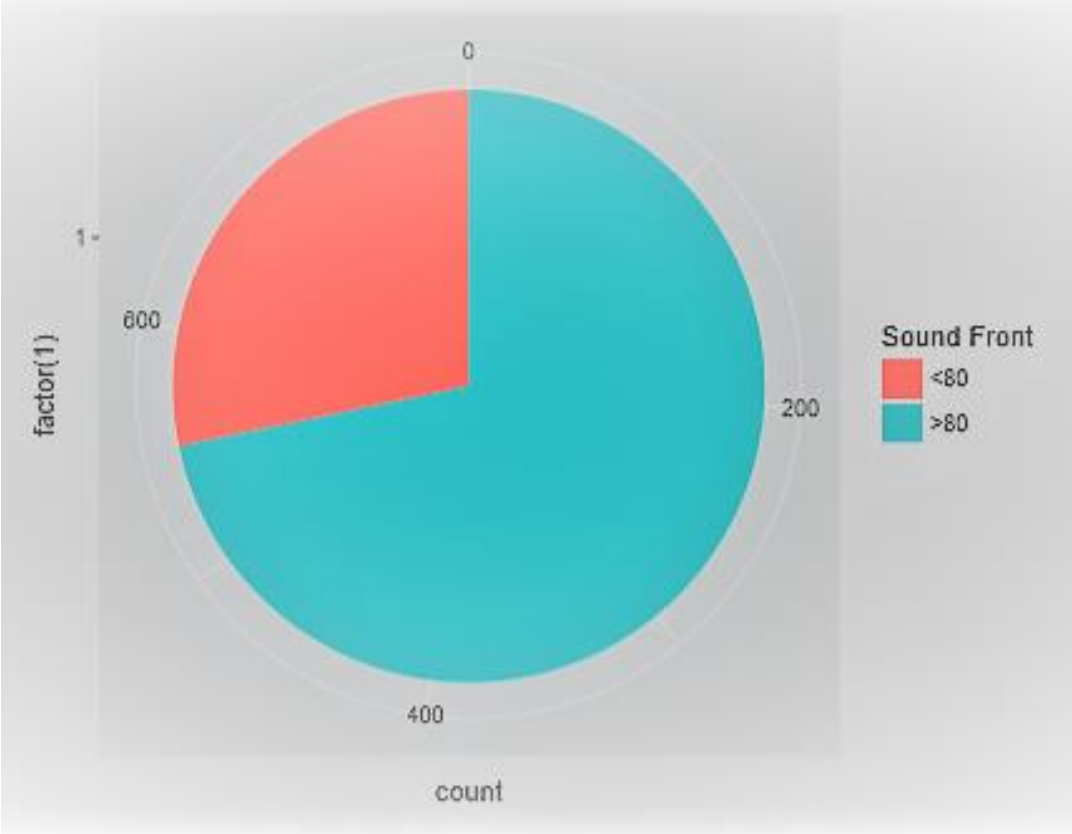

Figure 2.

Number of observations of sound levels recorded above and below 80 dBA in shelters in Connecticut.

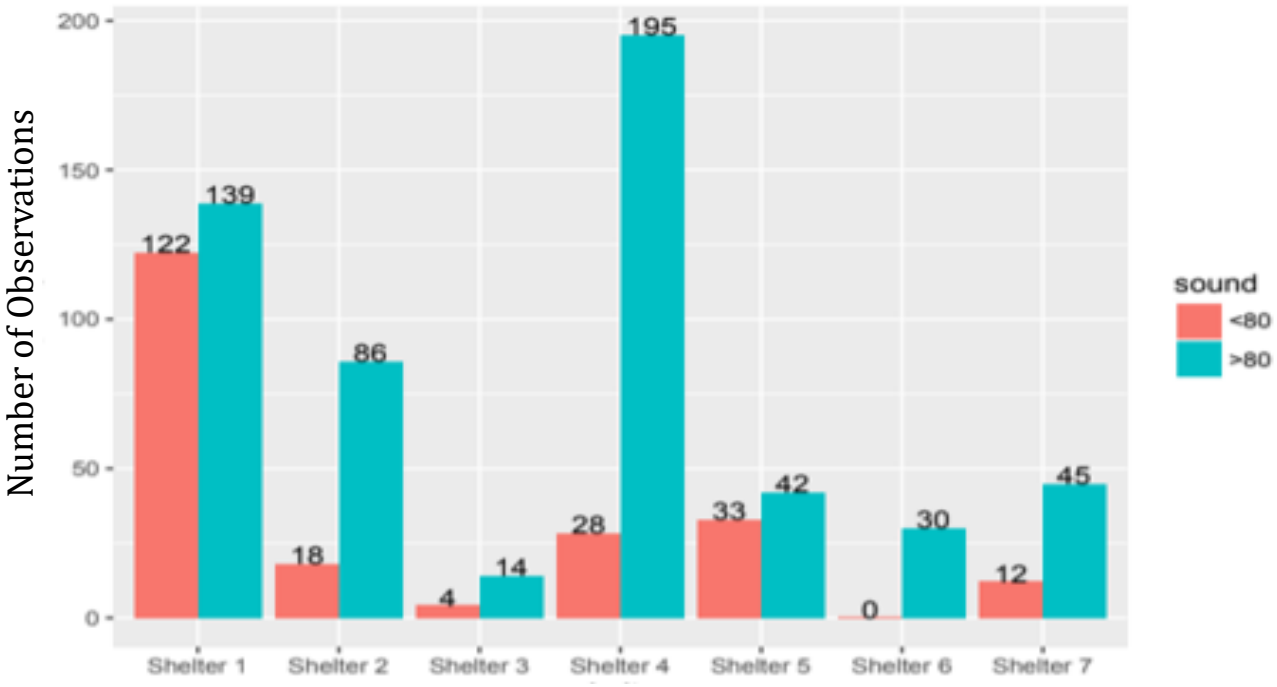

Figure 3.

Number of observations of sound levels in dBA recorded in Connecticut Shelters.

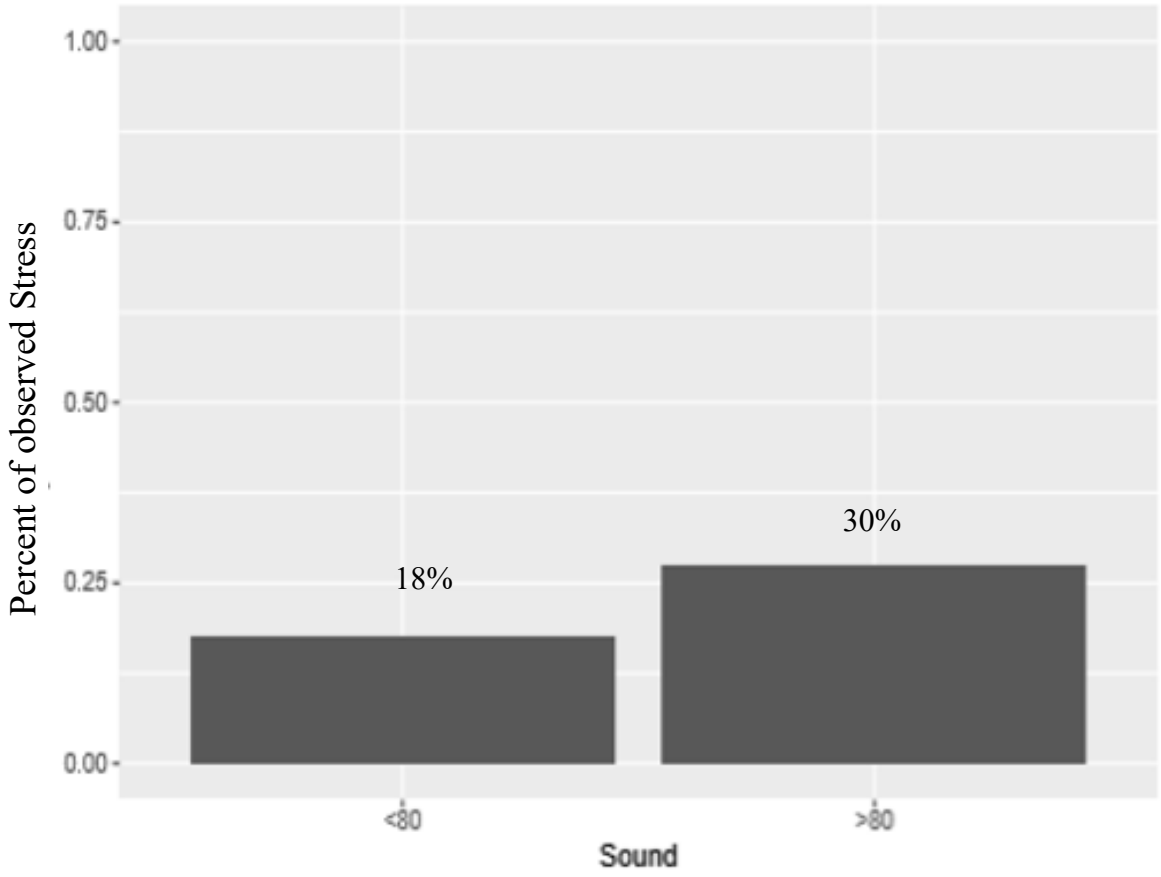

Figure 4.

The percentage of stress observed in dogs relative to sound intensity levels recorded in Connecticut shelters.

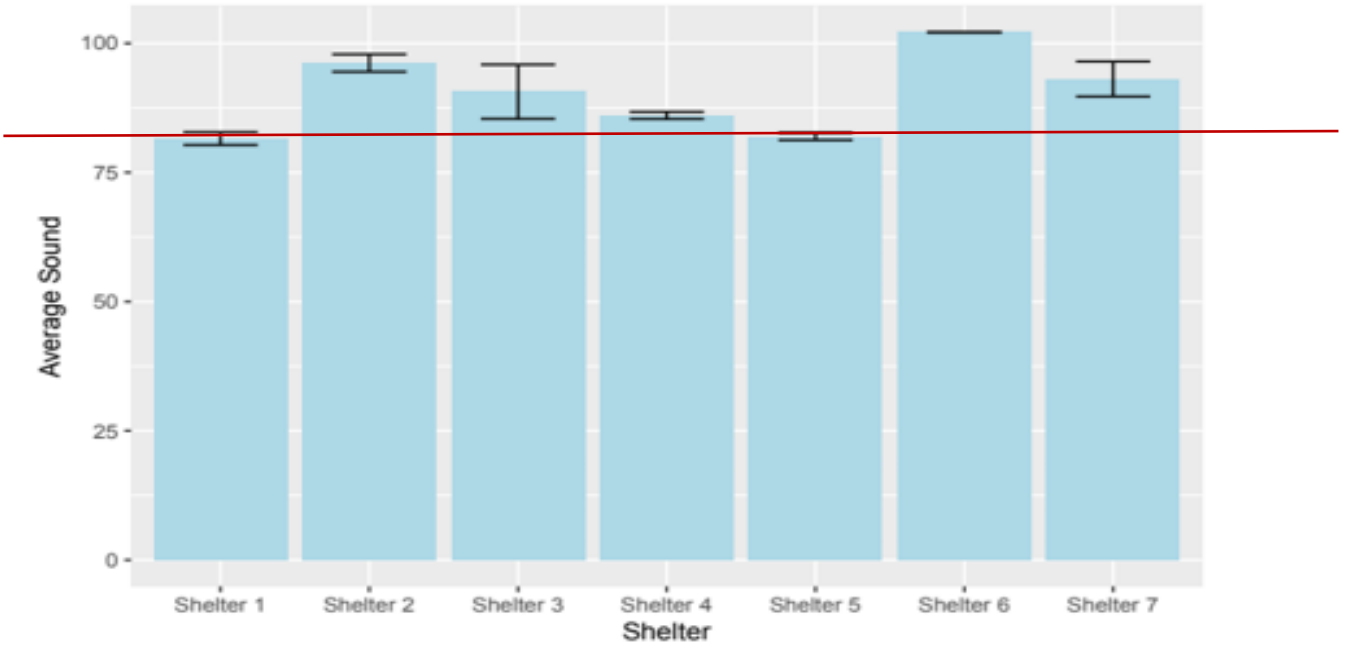

Figure 5. Sound using standard error bars in the seven Connecticut shelters. Red line indicates 80 dBA.

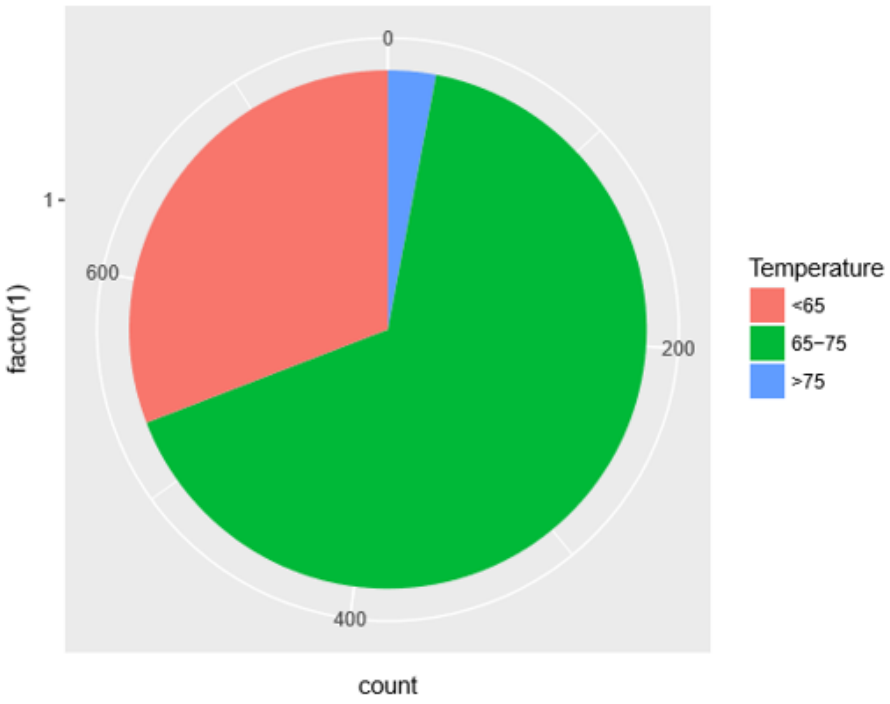

Figure 6.

The frequency of observations of temperatures within the ranges of less than 65° F, between 65°F and 75°F and greater than 75° F recorded in Connecticut shelters.

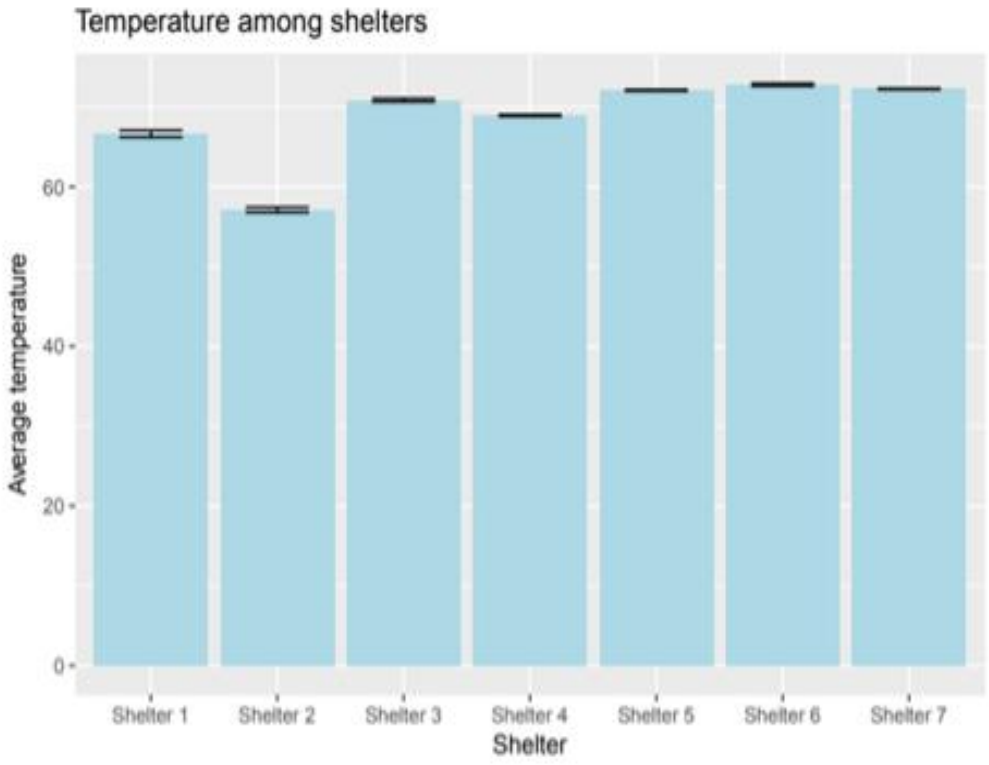

Figure 7.

Temperature using standard error bars in seven Connecticut shelters.

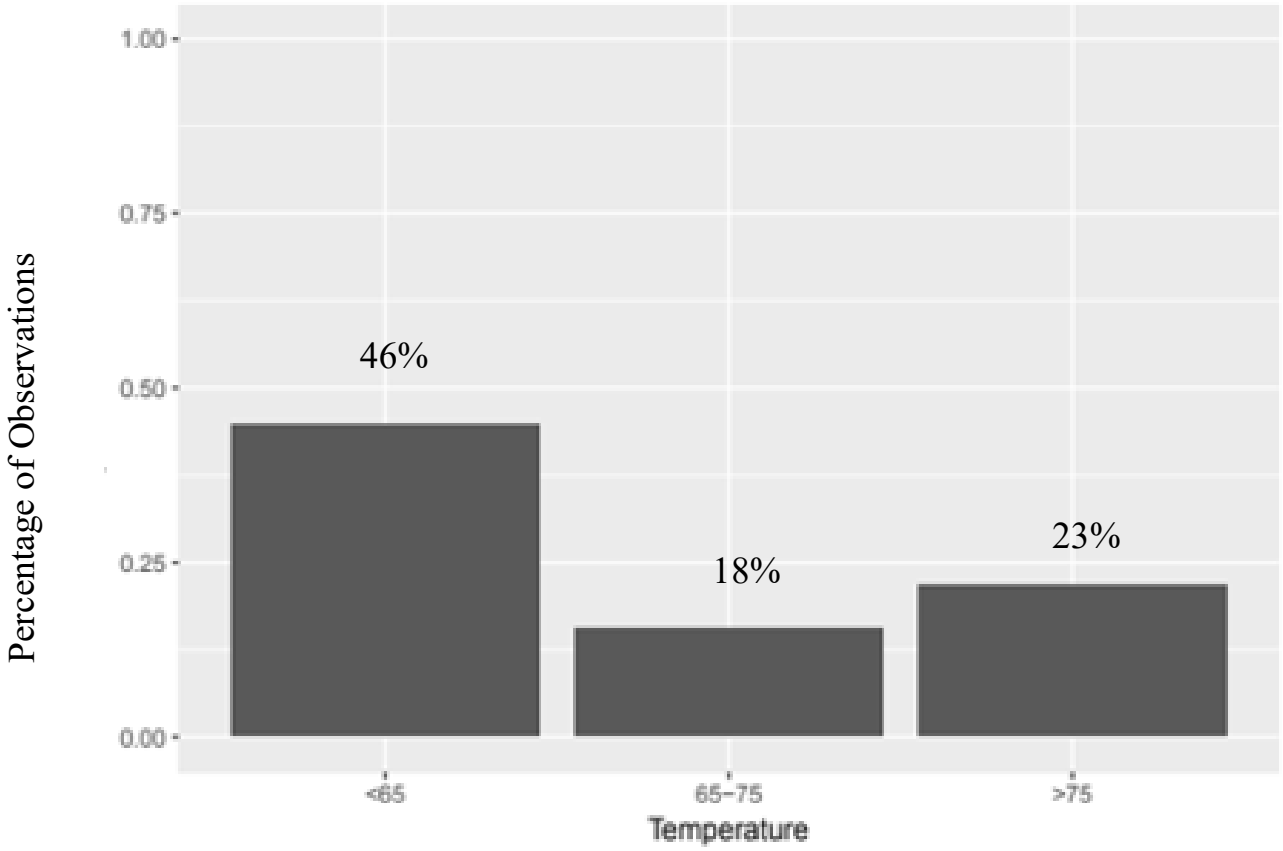

Figure 8.

Relationship between temperature and percentage of observed stress levels in kenneled shelter dogs in Connecticut shelters.

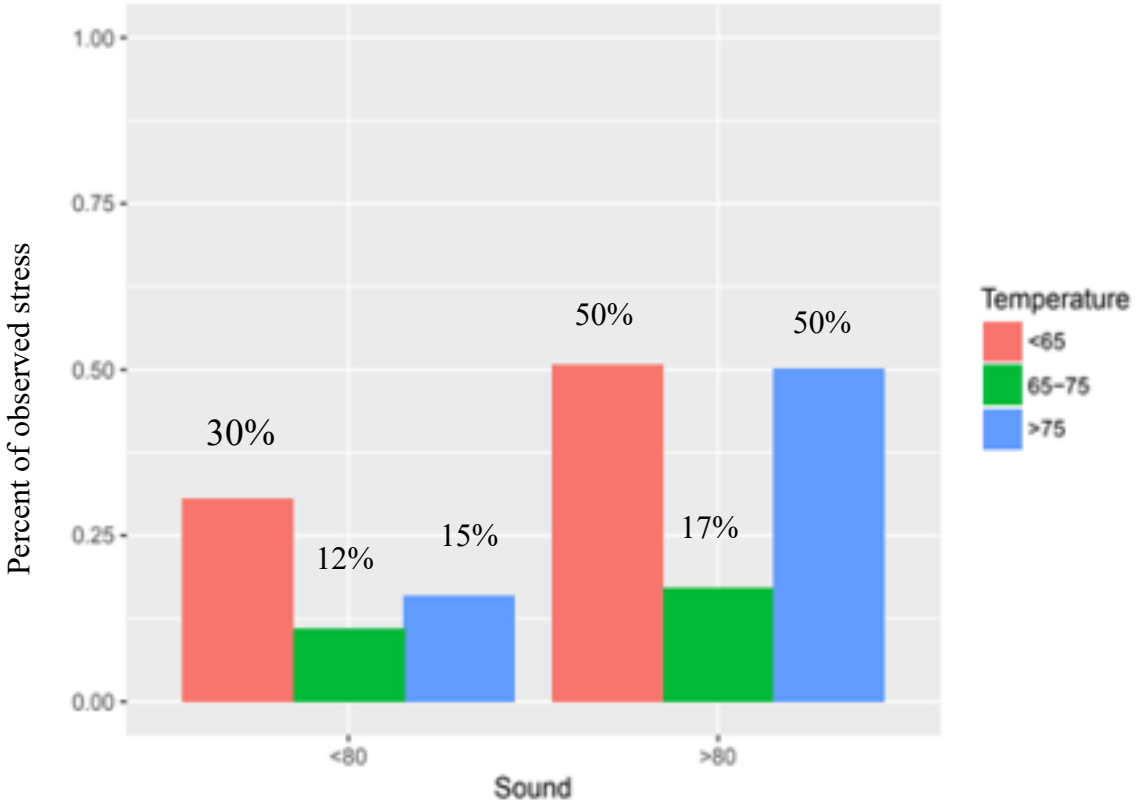

Figure 9.

Effects of the combination of sound levels in dBA's and temperature on the observed level of stress in kenneled shelter dogs in Connecticut shelters.

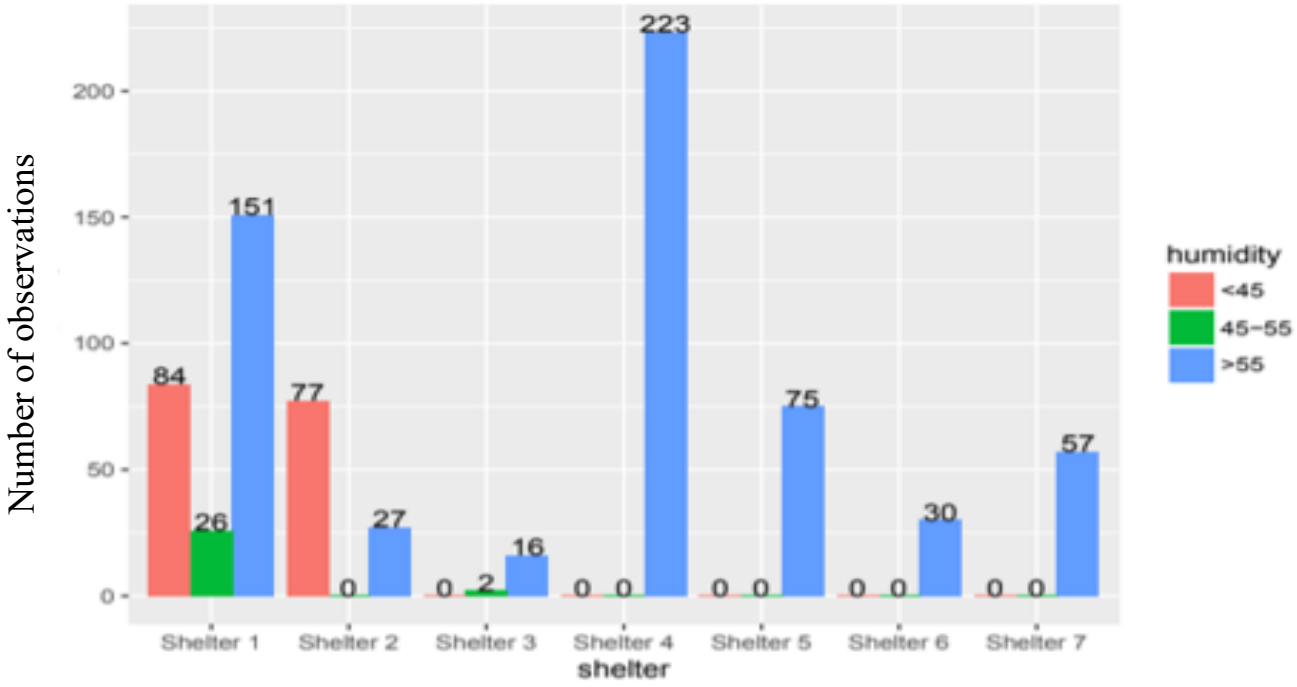

Figure 10.

Relationship between humidity and observed stress levels of kenneled shelter dogs within each of the seven Connecticut shelters.

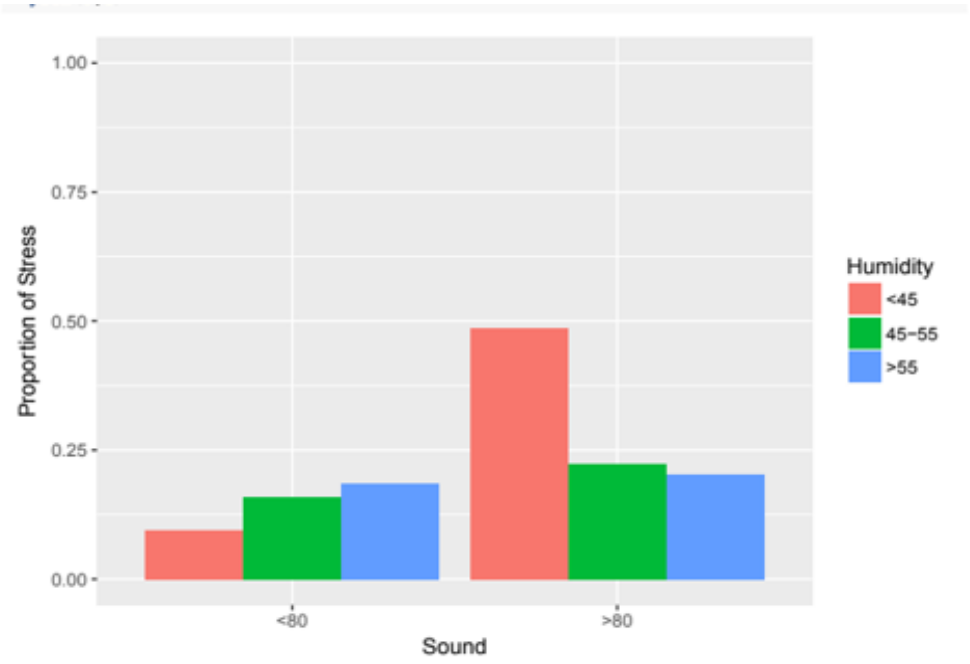

Figure 11.

Effects of the combination of sound levels in dBA's and humidity on the proportion of stress observed in kenneled shelter dogs in Connecticut shelters.

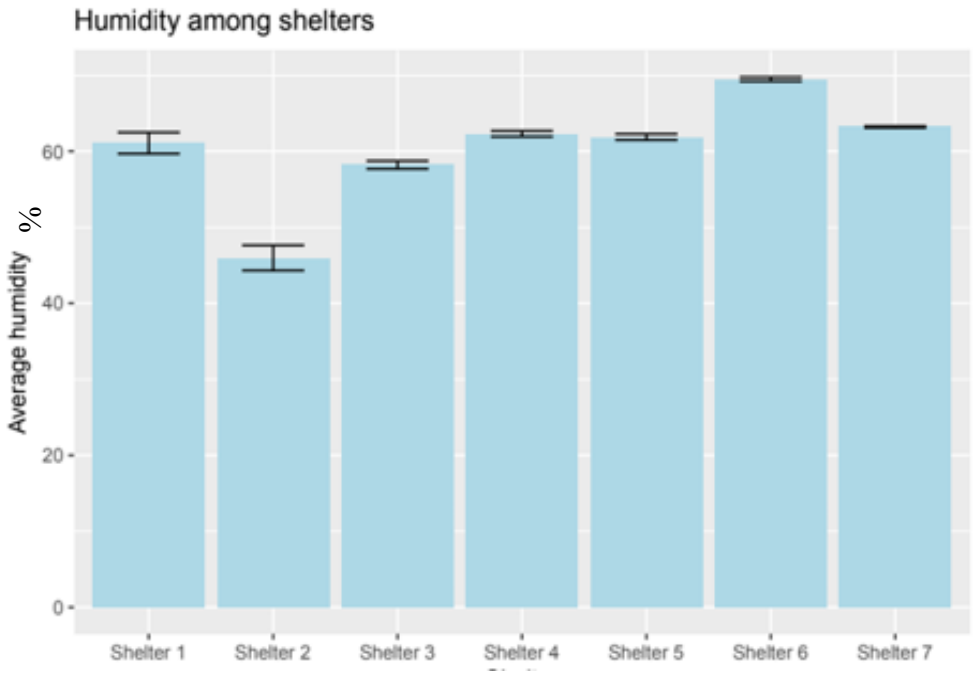

Figure 12.

Humidity in seven Connecticut animal shelters using standard error bars.

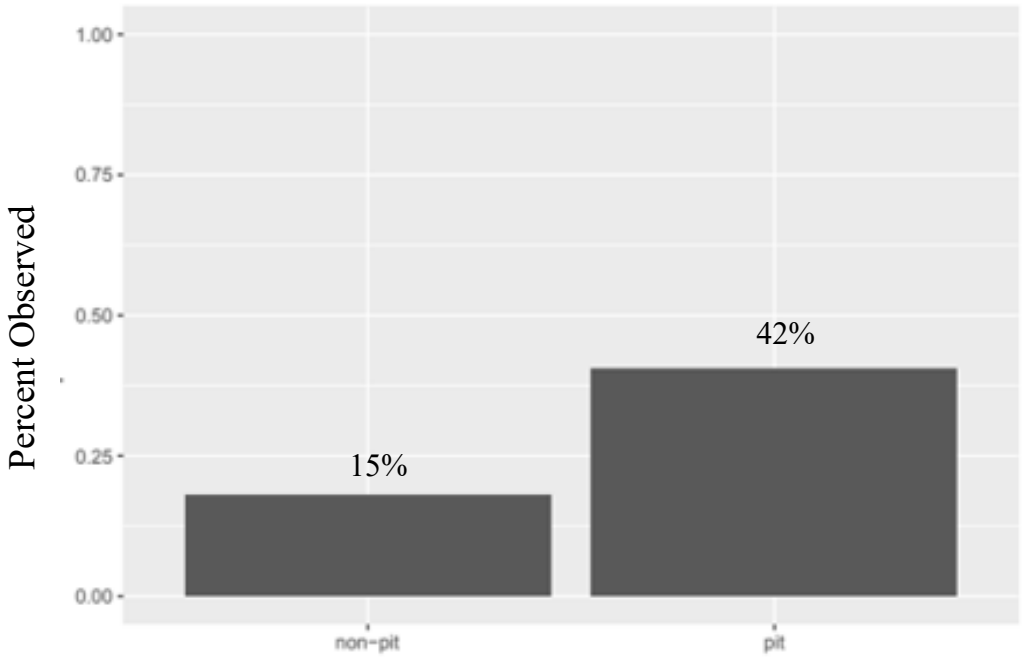

Figure 13.

Observed levels of stress in dogs labeled as non-pitbull breeds vs dogs labeled as pitbull mix breeds in kenneled shelter dogs in Connecticut shelters.

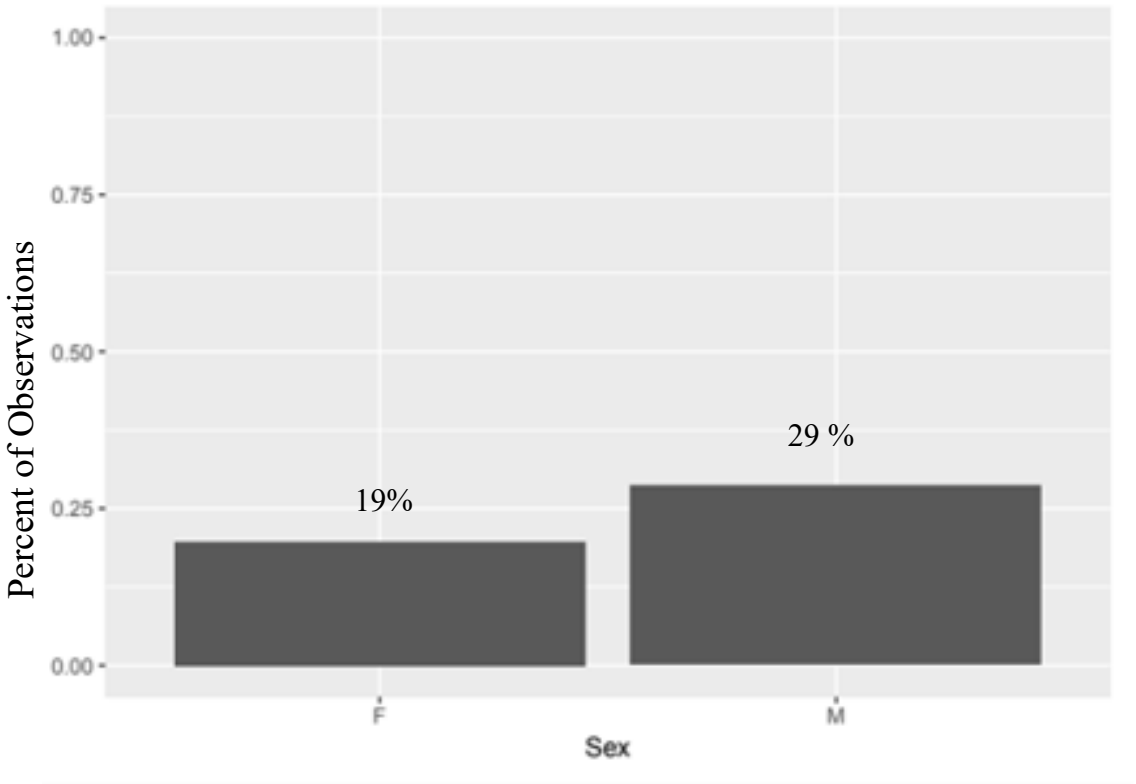

Figure 14.

Effects of gender on observed stress in kenneled shelter dogs in Connecticut.

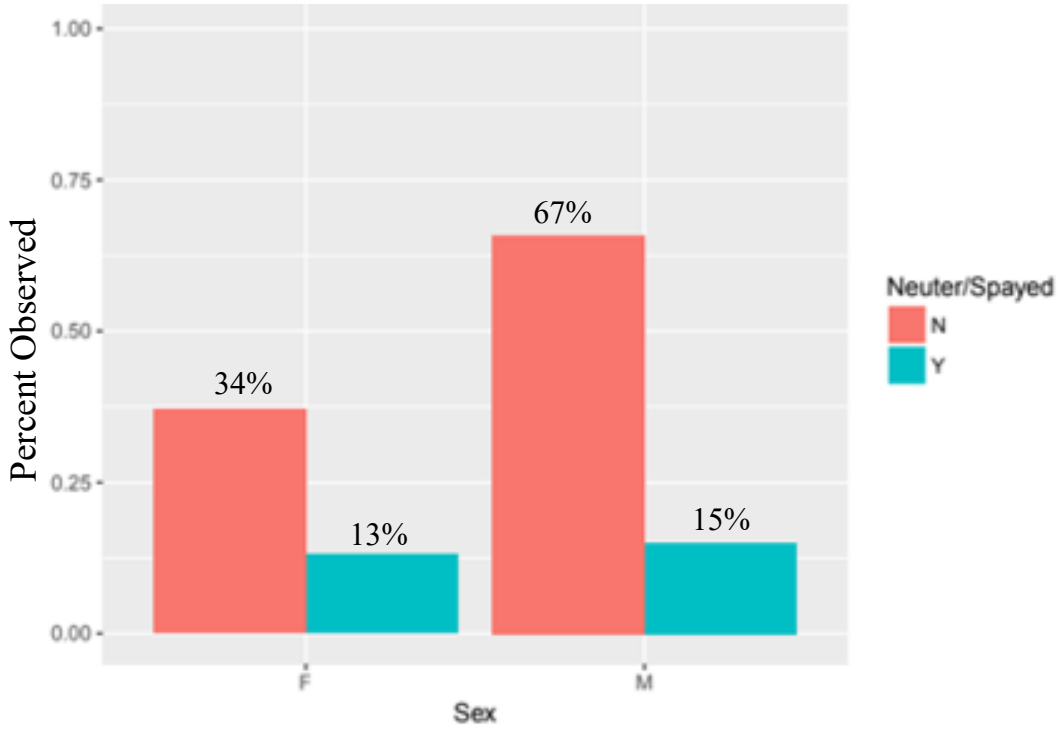

Figure 15.

Observed stress of altered (Y) versus unaltered (N) male and female kenneled shelter dogs in Connecticut shelters.

Table 1.

Variables	*P – value*
Breed P	0.021
Sex	0.111
Neuter/Spayed	0.001
Sound	0.001
Temperature	0.045
Humidity	0.348

With confidence level <0.05, Breed Pitbull, Neuter/Spayed, Sound, and Temperature are significant, which means these variables can influence the stress status.

Discussion

The development of a Canine Comfort Index with regards to temperature, humidity and sound was created to create ideal conditions for dogs housed in kennel shelter environments in Connecticut. These conditions are considered to be temperature in the range of 65° to 75 ° F, humidity levels between 45 and 55 % and decibel levels under 80 dBA's. These conditions were created with the assistance of veterinarians, trainers, and scientists.

Figures 2, 3, 4, and 5 foci on effects of sound levels measured in decibels on dog's behaviors in the 7 shelters where data was collected. There was a total of 551 observations above 80 dBA's and 217 below 80 dBA's. Approximately 72% of the 768 observations show that dogs in this study are exposed to decibel levels above 80dBA's. In figure 5, shelter's 1, 2, 4, and 5 have similar variations between the shelters. Shelter 3 and 7 have a large variation of sound and Shelter 6 has a small variation.

In Figure 4 it was noted that out of 551 observations (87 dogs exposed) nearly 30% were stressful above 80dBA and below 80dBA 217 observations (10 dogs exposed) 18% were stressful. Approximately 30% of dogs exposed to decibels above 80dBA's were displaying maladaptive behaviors One reason dogs may be displaying these maladaptive behaviors is because of hearing loss or hearing damage. The hearing range of a dog can vary based upon the breed, age, environmental factors as well as condition of the dog. The average audible range of frequencies for the typical dog is between 20 Hz to approximately 57,000 Hz, which represents an audible frequency range that is approximately three times the range of a human (Carmean and Vernetti, 2009). Couple that with the fact that a dog's audible frequency reception is enhanced by operation of the dog's ear flap (pinna) which is controlled by at least 18 different muscles, which operate to funnel audible frequency waves into the animal's ear canal (Carmean and

Vernetti, 2009). The dog's pinna may rotate in the direction of the sound therefore maximizing reception capability (Carmean and Vernetti, 2009). Sounds that may not be heard by a human are not only heard but could be loud and irritating which could even become debilitating to the dog.

According to the Occupational Safety and Health Administration, humans that are exposed to 8 hours of consistent noise of 90 dBA's or above have to be provided with ear protection. But many dogs are consistently exposed to noise levels well above that for extended periods of times while being housed in kennels. In a study utilizing mice being exposed to 100 dBA's for 2 hours conducted by Kujawa and Liberman, 2006, found that noise exposure even for short period of times can lead to permanent hearing damage that progresses with age. They also noted that there is a primary degeneration of the cochlear nerve. This study suggests that hearing loss can be continuous and long term over the life of the animals. If that is true, dogs that are consistently exposed to decibel levels above 80 dBA's may have permanent hearing loss and may also develop permanent maladaptive behaviors thereby making them less desirable as adoption candidates.

The results of this study suggest that canines exposed to sound levels 80 dBA's and above may have greater maladaptive behaviors in the kennels than those who are exposed to sound levels below 80 dBA's. The long-term exposure to 80 dBA's or above could cause permanent hearing loss which also could result in behaviors that are not desirable such as loud consistent barking, continuous pacing, whining, biting at the fencing and many others behaviors. These undesirable behaviors could ultimately make these dogs less adoptable and therefore increase the likelihood of being euthanized. Milligan et al. (1993) evaluated that sound levels were considered to be in the low range of 80-95 dBA's when dogs were barking in response to

human activity. Since shelter environments are constantly exposed to human activity because of both adopters walking through the kennel as well as staff and volunteers, sound levels could potentially remain above 80 dBA's for hours on end.

In Figure 9 it was noted that the proportion of stress was higher with regards to the 768 observations, 65% or 494 observations, showed that no matter what the temperature was, if sound levels were above 80 dBA's, dogs displayed more maladaptive behaviors. Additionally, in Figure 11 it was similarly found that below 45% humidity and above 80 dBA's displayed higher proportions of stress. Sound levels should be evaluated as a serious concern for dogs who have no choice in being housed in sheltering facilities. Modifying kennels with acoustical panels and hearing apparatuses for dogs, as well as quality construction when sheltering facilities are being built or modified should be considered. By modifying kennels, it could help alleviate hearing damage for dogs while they are housed at sheltering facilities. The added bonus of modifying these facilities is that it could also positively affect the care takers of these dogs as well as the potential adopters.

Figures 6, 7, and 8 describe that a majority of the 768 observations in the 7 shelters evaluated were within the range of 65-75° F. This range is considered within the Canine Comfort Index. In figure 8 there were 237 observations below 65° F and out of those 46% were stressful, There were 508 observations between 65-75° F and 18% were considered stressful. Above 75° F there were 23 observations which 23% were considered stressful. The concern however is when dogs in kennels are exposed to temperatures below 65° F or above 75° F for long periods of time especially when coupled with high humidity levels. Figure 8 indicates dogs exposed to temperatures below 65° F or above 75° F had higher levels of stress or maladaptive behaviors than those who were within the Canine Comfort Index (65-75° F). According to the USDA, it

can take anywhere from 7 to 60 days for a healthy dog to become acclimatized to high (more than 85° F) or low (less than 45° F) temperatures. The USDA notes that the best time to acclimatize a dog to a kennel environment is either in the spring or fall however dogs are abandoned at all times during the year so dogs could be at risk for heat stroke or cold stress if dropped off at a shelter and not yet acclimatized to the environment. The USDA also goes on to recommend that dogs that are at the greatest risk of suffering from heat stroke or cold stress are those that are in areas with relative humidity levels of more than 70 %, dogs that are considered obese, dogs that are considered seniors or puppies, dogs that have heart conditions or sick dogs, dogs with short or long coats, wet dogs, brachycephalic dogs or dogs that are dehydrated. Many of the observations were outside of the recommended Canine Comfort Index of 45-55% humidity (Figure 10). In Figure 12 it was noted that the humidity in shelter 6 was the highest while the humidity in shelter 2 was the lowest. Shelters 1 and 2 had a relatively large variation of humidity levels. If higher humidity levels are combined with high temperature levels, it could potentially be causing life threatening situations to dogs or puppies that are not acclimated to the kennel environment**.** All of these conditions should be considered very carefully when placing a dog in the shelter environment.

The Canine Comfort Index values have been suggested by evaluating the USDA recommendations for dogs housed in kennels which stated that dogs should not be subjected to any combination of temperature and humidity for a duration that is detrimental to the animal's health or well-being, taking into consideration such factors as the animal's age, breed, overall health status and acclimation (USDA, 2017). The Institutional Animal Care and Use Committee also made recommendations regarding providing proper temperature and humidity to animals by stating that a properly designed and functioning HVAC system is essential to provide

environmental and space pressurization control. Temperature and humidity control minimizes variations due either to changing climatic conditions or to differences in the number and kind of animals and equipment in an animal holding space (e.g., a room or cubicle) (IACUC, 2018).

For this study, data that was recorded in shelters 1, 3, 4, and 5 were all evaluated in the summer months but shelter 1 was evaluated again in a winter month as well. Shelter 2 was evaluated in the winter. Data collected in Shelter's 6 and 7 was completed in the Spring. Shelters 3 and 5 were completely enclosed so they had the most control over temperature, humidity and lighting. In shelter 4 they also had separator concrete walls that ran down the middle of the kennels to help control acoustical levels for dogs in the adoption area. The wall seemed to help alleviate some stress and noise levels. All of the other shelters were open kennel environments, so dogs had access to both inside and outside portions of the kennel.

Also evaluated was the maladaptive behaviors of males versus females, unneutered male's vs neutered males as well as un spayed females versus spayed females. This study also looked at the behaviors of dogs labeled as pit bull or pit bull mixes versus those labeled as other breeds. Dogs that are in kennel environments that are un spayed or unneutered may have the added physiological stress of being in heat or being ready to mate but yet being unable to access another dog. This could create another potentially stressful situation since multiple male or female unaltered dogs may want to mate with the same dog and could appear aggressive in their kennels since they are unable to meet that need. Lepper et al 2002, evaluated dogs that were altered versus unaltered in shelter settings and found that adopters considered altered dogs more desirable. This could be because those dogs that are already altered may appear calmer, less aggressive and have more socially acceptable behaviors.

In total there were 97 dogs evaluated. There were 17 unneutered males, 35 neutered

males, 15 unspayed females and 30 spayed female dogs in kennels. This study indicated that male dogs housed in sheltering facilities in Connecticut appeared more stressed compared to females Male dogs appeared to display more maladaptive behaviors in kennels when compared to female dogs (Figure 14).

This research also found that if females or males were left unaltered there was no difference between sex, meaning both appeared to have more maladaptive behaviors while in the kennels compared to those dogs that were altered (Figure 15). A study conducted by Protopopoya et al. 2014 found that a dog's kennel behavior may predict the length of stay at the shelter. Dogs that exhibited what is considered socially unacceptable behavior such as increased back and forth motion in the kennel, contact with the enclosure, and faced away, regardless of morphology, had a longer length of stay at the shelter (Protopopoya et al. 2014).

This research indicated that dogs that were vocalizing in a whining, growling or groaning, as well as jumping, circling, lunging and biting the kennel fencing displayed the most maladaptive behaviors in kennel settings. Beerda et al.1998 noted that restlessness of canines or body shaking as well as lowering the posture of their body indicates stress. Dr. Seong Chan Yeon, 2007, found that dogs start yelping and whining as young as 20-24 days. The whining is considered to be a vocalization a pup makes when in pain or is extremely distressed. Dr. Yeon also recognized that groaning or growling was typically associated with extreme distress or an aggressive display when dogs were in physically uncomfortable situations.

Dogs labeled as pit bull mix type breeds showed a higher proportion of stress than dogs labeled as non-pit bull type breeds (Figure 13). Out of 235 observations for dogs labeled as pit bull type breeds, 95 of them were shown to have maladaptive behaviors. Pit bull type breeds are many times labeled as higher energy dogs. They are also known to be strong dogs needing a

stable handler. Because of being both a higher energy dog and requiring a strong handler, these dogs may not be handled regularly by staff or volunteers at shelters or may be incorrectly labeled as aggressive because of their behaviors therefore they are not handled or taken out of their kennels. This misconception is true for many high energy dogs which may display with undesirable behaviors in kennels within shelter settings. This could partially be caused by dogs not having human contact or not having contact and socializing time with other dogs. Dogs interacting with humans has been known to reduce behavioral signs of excitement such as jumping or vocalizing or exhibiting fearful behaviors such as panting (Shiverdecker et al. 2013). These findings suggest shelter dogs interacting with humans on a daily basis could reduce stress and potentially improve welfare of dogs in a shelter setting (Shiverdecker et al. 2013).

In Table 1 it was noted a p-value less than 0.05 was deemed statistically significant. Breed Pitbull, dogs being spayed and neutered, sound and temperature were all significant. All appeared to influence dogs stress response as indicated by their displaying maladaptive behaviors while in kennels in shelters within Connecticut.

Conclusion:

Environmental factors can have significant effects on dog's behaviors while in kennel settings. These behaviors could be modified with some alterations to current shelter environments. Some alterations to be considered would be housing canines in more ideal conditions. Ideal conditions are considered to be temperature in the range of 65° to 75 ° F, humidity levels between 45 and 55 % and decibel levels under 80 dBA's. These ideal conditions we have named the Canine Comfort Index.

More research needs to be conducted in order to determine other environmental factors which could impact the welfare of kenneled dogs such as light, nutrition, enrichment items for the kennels such as plants, music etc as well as enrichments factors for dogs such as calming scents, toys, and other items. Ultimately the more research that is conducted on the welfare of shelter dogs will give society a better understanding of how we can improve adoptions and therefore decrease euthanasia.

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